Exploring the Gurteen Knowledge Café approach as an innovative teaching for learning strategy with first-year engineering students

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***Abstract**: This study explored a learning approach based on the Gurteen Knowledge Café to encourage collaborative learning in a first-year Mathematics module. The rationale for carrying out this exploration was to empower students to become active, responsible and critical learners. The study was carried out with 32 first-year Electrical Engineering students at a South African university of technology, who were divided into five groups and engaged in mathematics tasks structured in the form of activity sheets and the general pedagogy was guided by social constructivism. Written responses, classroom activity observations and questionnaires contributed to the data. The activities involved five tasks on hyperbolic functions in preparation for first-year Calculus. Findings emanating from the data analysis indicated that this approach to collaborative learning provided positive attributes which aided effective Mathematics learning and learning in general.*

***Keywords**: collaborative learning, constructivism, hyperbolic functions, Gurteen Knowledge Café, induction, groupwork*

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Introduction

Current trends in South African higher education institutions are to focus both on research and on the quality of teaching. It is with the latter in mind that this study was carried out at a South African university of technology. In keeping with this institution's vision to become a student-centred university, the academic induction programme explores student-centred learning, teaching and assessment strategies (CELT, 2013). As part of this programme the newly appointed staff member is required to demonstrate how he/she has engaged in practice that has led to a degree of transformation in his/her classroom practice. With this in mind I, as a newly appointed staff member at this institution, decided to incorporate one of the didactical approaches discussed in one of the induction sessions to encourage collaborative learning in one of my Mathematics classes. This was done in order to determine the outcomes of such an intervention. It was found that the theory of constructivism, described in more detail below, best suited a conceptual framework for this exploration. Young & Collin (2004) mention three frequent positions adopted within constructivism: a) radical constructivists, b) moderate constructivists and c) social constructivists. For this study I found that structuralism would enhance effective student learning via collaborative learning. The modified version of the Gurteen Knowledge Café approach was used as a learning approach based upon structuralism, a social constructivist position within the overall constructivist family (Young & Collin, 2004). This paper provides reflections on the Gurteen Knowledge Café groupwork method and uses data from student accounts in situ to aid these reflections.

With this in mind, I framed the following research question:

> How may a modified version of the Gurteen Knowledge Café approach benefit first-year Engineering students' learning of hyperbolic functions in preparation for Calculus?

A Knowledge Cafe is a means of bringing a group of people together to have an open, creative conversation on a topic of mutual interest to share their collective knowledge, ideas and insights and to gain a deeper understanding of the subject and the issues involved (Gurteen, 2012).

The Knowledge Café method has multiple origins with links to other related methods such as The World Cafe. Elizabeth Lank formulated the concept creating a physical and mobile cafe area in the 1990s. It has been made popular by Charles Savage Knowledge Era Enterprising and recently by David Gurteen, a UK-based consultant specialising in knowledge management. The Knowledge Café begins with the participants seated in a circle of chairs (or concentric circles of chairs if the group is large or the room is small). It is led by a facilitator, who begins by explaining the purpose of Knowledge Cafés and the role of conversation in business life. The facilitator then introduces the café topic and poses one or two key open-ended questions. The Gurteen Knowledge Café approach spans over one to two hours. In my case each lecture is less than an hour's duration and so to take account of this I had to modify the approach as outlined by the Gurteen Knowledge Café. . My modifications to the Gurteen Knowledge Café approach provided a useful variation to previous studies. In this study students were allowed to rotate in group activities meaning they worked with different peers to construct solutions to the given mathematics tasks.

Theoretical framework

Constructivism is a cognitive learning theory with a clear focus on the mental processes that construct meaning. Cobb (1994) and Confrey (1990) assert that the principles of constructivism are founded largely on Piaget's processes of assimilation and accommodation, where assimilation refers to the use of existing schemas that give meaning to experiences, and accommodation is the process of altering ways of viewing things or ideas that contradict or do not fit into existing schemas. In this study the individuals not only have to reflect on set mathematical tasks, but also have to share their reflections with fellow students. Ornstein and Hunkins (2004) describe constructivism as being a realm concerned with how an individual learns, which places the individual as an active person in the process of thinking, learning and coming to know.

Piaget's study (1970) of the cognitive development of children brought him to the conclusion that knowledge is actively constructed by each individual. He contends that what is crucial to intellectual development is a shift in focus from the properties inherent in real-world objects as actions are applied to them, to a consideration of the actions themselves and the effect they have on objects. Through this shift in focus, knowledge is obtained from the actions which the individual performs, leading to a constructed abstraction of the action process. In his book *Genetic Epistemology*, Piaget (Piaget, 1972, p.16) wrote: 'The abstraction is drawn not from the object that is acted upon, but from the action itself. It seems to me that this is the basis of logical and mathematical abstraction.'

In this exploration the participants were required to draw abstractions from tasks based on hyperbolic functions. According to Steffe (1992) Piaget can be considered as the father of constructivism, and those who have followed him have provided several useful insights which have led to a great change in the way in which Mathematics is seen today, compared to in the past.

The constructivist Von Glaserfeld (1984) argues that reflective ability is an important source of knowledge at all levels of Mathematics, and it is therefore vitally important that learners are guided and directed to talk about their thoughts to each other and to the teacher as well. He emphasises that talking about what one is doing confirms that one is examining it. In this study the effect of such examinations resulted in the learners discussing their view of the problem and their own cautious approaches. In this study we hoped to elevate students' self-confidence as they developed more viable conceptual strategies to solve tasks on hyperbolic functions.

Confrey (1990) asserts that knowledge does not merely arise from experience but rather from the interaction between experience and our present knowledge structures. The learner is no longer viewed as a passive recipient of knowledge from the environment; the learner becomes an active participant in the construction of knowledge. Confrey (1990) terms a unit of interrelated ideas in a child's mind as a schema, where new ideas that are interpreted and understood by the learner according to the learner's own current knowledge and previous experiences. These schemas can be considered useful tools, which are memorised for retrieval and use at a later stage. Learning now becomes an interaction between a child's schema and new concepts, ideas or experiences.

When new ideas cannot be linked to any existing schema, then a learner would engage in creating a new ‘box’ and attempt to memorise the idea (Eggen & Kauchak, 2007). Confrey (1990) terms this rote-learning, as this new idea cannot be connected to any previous knowledge and as a result is not understood. This knowledge is isolated and becomes tough to remember. Providing an opportunity to engage in discussion with fellow students, we felt, could aid memory, and we fostered this through learning in groups.

Collaborative learning

Vygotsky (1978) states that social constructivism is knowledge construction that is a shared experience rather than just an individual experience. It is through the process of sharing individual perspectives that learners construct understanding. According to Noddings (1990) constructivists maintain that learning is an active process, and one that needs the active participation of the learner. Brijlall, Maharaj and Jojo (2006) add that learning without participation is a contradiction of the recommendations of constructivists such as Von Glasersfeld, who strongly believes that reflective ability is a major source of knowledge at all levels of Mathematics. This infers that it is important for learners to talk about their thoughts to both each other and the teacher.

Collaborative learning allows learners to think critically, make decisions and promote communication skills. Such learning allows learners to understand each other and also promotes their linguistic skill: ‘Peers are often seen to be better teachers of ideas than teachers, because they understand each other’ (Vithal, Adler & Keitel, 2005, p.147). I agree with this point, because I had observed that learners understood each other easily when they explained to one another, and were able to ask questions when they needed clarification of a problem.

Barkley, Cross and Major (2005, p.132) state that ‘When interacting in groups, the participants purposefully implement social constructivist learning theory, a theory contending that knowledge is socially constructed by consensus among knowledgeable peers’. This is true, because the learners are expected to actively help and support one another. Members share resources and support and encourage each other’s efforts to learn. Groups are very important because of the purpose they have to serve: to engage students actively in their own learning and to do so in a supportive and challenging social context, as suggested by Barkley et al, (2005).

During collaborative learning in problem solving, the role of the teacher within collaborative approaches is to provoke cognitive conflict, since these approaches hold that conceptual growth occurs as learners resolve conflicting points of view and different approaches to tasks (Vithal et al, 2005). I also believe that this study is necessary because 'Neurologists and cognitive scientists agree that people quite literally 'build' their own minds throughout life by actively constructing the mental structures that connect and organise isolated bits of information' (Barkley et al, 2005, p.145). The important concept is that learners actively make the connections in their own brains and minds that produce learning for them (Barkley et al, 2005).

Vygotsky invented the term 'Zone of proximal development' (ZPD) to indicate 'the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaborative with more capable peers (Barkley et al, 2005). For the collaborative learning to be effective, group size should range from two to six students. Collaborative learning advocates suggest that the group be small enough so that students can participate fully and build confidence in one another, yet large enough to have sufficient diversity and the necessary resources to accomplish the learning task (Barkley et al, 2005). I also found that for collaborative learning to be effective, I had to observe groups. This helped me to acquire information about group interaction, identify problems and determine whether students were achieving learning goals. When I was observing, I found information on how things were going and created opportunities to redirect students or probe them with questions to promote deeper learning.

Groupwork was encouraging learners to verbalise their ideas and feelings, and this helped them to understand the subject matter. Some of the learners were very effective at explaining ideas to others, in language they found easy to understand. This helped both the explainer and the other group members to master the content. This mastery of the content is made possible as members learn about their own personal problems from being present as the similar problems of fellow members are worked with (Douglas, 2000). Groupwork allowed learners to experience roles as leaders, peers and subordinates, and to experience a range of social contacts. In addition, mixed-ability grouping could encourage lower-ability learners to persist in difficult tasks (Noddings, 1990).

Five factors for effective group organisation are suggested by Noddings (1990). First is a feeling of competence by learners; this is an outcome of the composition of groups and the pupils' perception of the teacher's role in the whole process. To compensate for this we allowed students to choose the groups they would like to work with. Second is common ground – pupils' abilities to restate and reorganise presented situations into representations they can all share. The use of language at the pupils' level is all important at this stage. During the classroom observation I noticed that the common medium of English was used in all group discussions. Third is focusing, which is the teacher's ability to present a problem framework which provides the kind of help needed to start pupils thinking and starting to ask their own relevant questions. The activity sheet was designed to cover all types of application of hyperbolic functions. Fourth is pace – basically allowing time for exploratory talks to take place. A balance is required between allowing time for learning to take place and time to show that the job has been done. In this exploration sufficient time was allowed for task interrogation and discussion. The fifth factor is making public – the need to refine language appropriate to a wider audience. For example, group reporting back to the whole class would require a spokesperson to collect and present the findings of the group using more explicit language, so that other groups less familiar with the situation could appreciate the points being made. For this study the spokesperson was the anchor within each group.

Hyperbolic functions

Engineering students are introduced to many different mathematical relations called functions. One set of functions is called hyperbolic functions. These functions are necessary for this career field as they appear in differential equations which describe vibrations in machines. Graphs of the respective functions are sketched and tasks involving simplification, solving of equations, conversion from exponential to hyperbolic functions and from hyperbolic to exponential forms and expressing hyperbolic functions into logarithmic forms are carried out. The definitions (Stroud, 2007) we adopted were:

$$\sinh x = \frac{e^x - e^{-x}}{2}, \quad \cosh x = \frac{e^x + e^{-x}}{2}, \text{ and } \tanh x = \frac{e^x - e^{-x}}{e^x + e^{-x}}$$

Methodology

> Methodology refers to the coherent group of methods that complement one another and that have the 'goodness of fit' to deliver data and findings that will reflect the research question and suit the research purpose' (Henning, 2004, p.36).

According to Cohen, Manion and Morrison (2007, p.47) research methods are a

> range of approaches used in educational research to gather data which are to be used as a basis for inference and interpretation, for explanation and prediction'.

In this study we used a qualitative approach, collecting data from activity sheets and a questionnaire. Prior to commencement of administration of the activity sheets and questionnaire, consent from the relevant university authorities and participants was obtained. The institution's ethical guidelines were maintained. The questionnaire was used to triangulate the data retrieved from the written responses on the activity sheets. The activity sheets had five tasks which involved hyperbolic functions (Figure 1 overleaf).

Each of the five groups was given a task to complete. The instructions (which were to create an environment for the Gurteen Knowledge Café approach to occur) on the activity sheet were:

1. Elect an anchor in your group,
2. You are required to discuss a solution to the given task,
3. At the end of 10 minutes, all members (except the anchor) are required to move to the next group in order of numerical sequence,
4. You should ensure that you have been to all groups and have attempted the solution of all tasks,
5. The anchor must submit the written solution to your tutor.

Task 1: Simplify $\sqrt{\dfrac{\sinh x + 1}{2}}$ **into an exponential form.**

Task 2; Solve for *x*: $3\cosh 2x = 3 + \sinh 2x$ **.**

Task 3: Using the exponential definition of $\sinh x$ **, show that** $\sinh^{-1} x = \ln\left(x + \sqrt{x^2 + 1}\right)$**.**

Task 4: If $\tanh^{-1} x = \dfrac{1}{2}\ln\left(\dfrac{1+x}{1-x}\right)$ **, show that** $\tanh^{-1}(\cos 2\theta) = \ln(\cot\theta)$**.**

Task 5: The value of x given that $\sinh 2x = 1{,}343$ **is?**

Figure 1: The five tasks given to the groups

These instructions were aligned with some changes which were made to the original Gurteen Knowledge Café approach. I divided a class of students into several smaller groups. Each group had a different task and an anchor member who did not move from the group. After 10 minutes all the members, except the anchor member, moved to the next table and task. The initial task was not completed in 10 minutes and the new group of students would pick up the task wherever the previous group left it. However, the anchor member would explain where the previous group left off, in many ways acting as a culture/knowledge bearer for each new wave of group. The new set of members was allowed to contribute to the task when they were in the group that they had moved to. This process continued until the migrating members had visited all tasks and the five tasks were completed. This method of groupwork learning is the focus of this paper. The mathematical attributes which emanated from the data analysis provided empirical justification for the successes of this method of groupwork.

The class consisted of 43 students; 32 of whom agreed to participate in this exploration, so only data pertaining to these students were used for the analysis. However, the other 11 students formed two groups and worked on all five tasks. We focus in this study on the 32 students in five groups, two consisting of seven members and three groups comprising six members each. The classroom design did not support collaborative learning as the desks were elongated ones fixed to the floor. The researcher improvised by moving chairs to different points in the classroom. The students turned chairs around so that they could face each other and talk to one another

The group session was an hour long, and was utilised for group discussion guided by the didactical approach based on the Gurteen Knowledge Café. At the end the students were each provided with a questionnaire which they had to complete at home, and they handed them back to the researcher the next day. The questionnaire contained the following questions: 1) Did you enjoy the learning activity? 2) Could you explain why you enjoyed/did not enjoy the activity? 3) Do you feel that you learn more in groups or as individuals? Explain fully. The written group responses and questionnaire were analysed, and a discussion of the data analysis and findings is presented next. The participants were coded in accordance with their names (for example, a student with the name Smith Darren was coded Student SD).

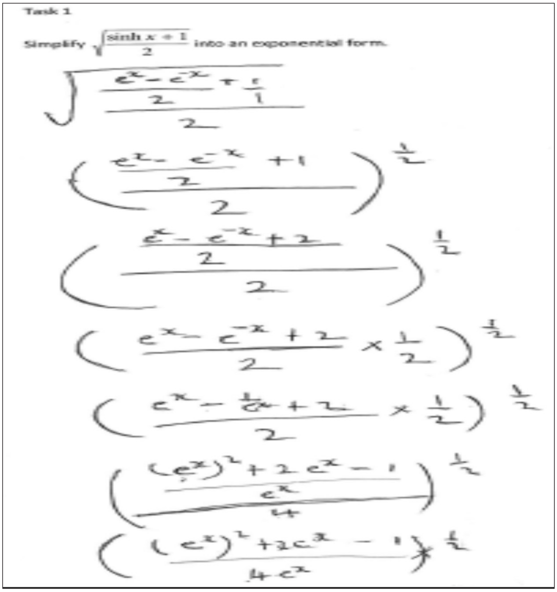
Data analysis and discussion

The data are discussed according to task and the written response for each of the tasks is presented sequentially in Figures 3-7. Each individual task was solved once, but five groups contributed to the completion of the tasks .The written response for task 1 appears in Figure 2 overleaf.

We note that after all the groups had visited and discussed the solution to task 1, a successful transformation of the expression from the *sinh x* function to the exponential function was achieved. The students displayed the following knowledge and skills: 1) they could correctly define the *sinh x* function (see line two of Figure 3), 2) they could convert a surd (a number which cannot be simplified to remove a square root) into an exponential form, 3) they could correctly add algebraic fractions (see lines 3 and 6 of Figure 3), 4) they could relate multiplication into division when fractions were involved (see line 4 of Figure 3), and 5) they applied the exponent law governing positive exponents correctly.

However, one glaring shortfall in the presentation was the omission of the = sign throughout the written response. So we conclude that despite all the participants having visited this task, some omission occurred. The positive aspect of the written response was the demonstration of much mathematical skill and knowledge.

For Task 2 (see Figure 3), we observe that the written response


Task 1

Simplify $\sqrt{\frac{\sinh x+1}{2}}$ into an exponential form.

$$\sqrt{\frac{\frac{e^x-e^{-x}}{2}+\frac{1}{1}}{2}}$$

$$\left(\frac{\frac{e^x-e^{-x}}{2}+1}{2}\right)^{\frac{1}{2}}$$

$$\left(\frac{\frac{e^x-e^{-x}+2}{2}}{2}\right)^{\frac{1}{2}}$$

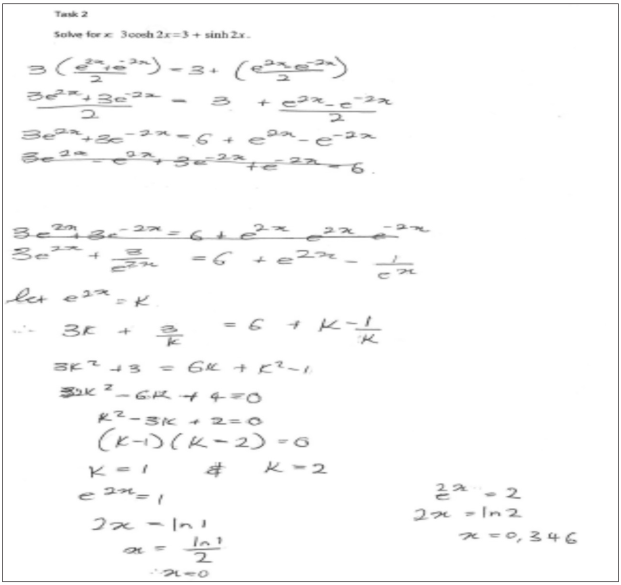
$$\left(\frac{e^x-e^{-x}+2}{2}\times\frac{1}{2}\right)^{\frac{1}{2}}$$

$$\left(\frac{e^x-\frac{1}{e^x}+2}{2}\times\frac{1}{2}\right)^{\frac{1}{2}}$$

$$\left(\frac{\frac{(e^x)^2+2e^x-1}{e^x}}{4}\right)^{\frac{1}{2}}$$

$$\left(\frac{(e^x)^2+2e^x-1}{4e^x}\right)^{\frac{1}{2}}$$

Figure 2: Written response for task 1


Task 2

Solve for x: $3\cosh 2x=3+\sinh 2x$.

$$3\left(\frac{e^{2x}+e^{-2x}}{2}\right)=3+\left(\frac{e^{2x}-e^{-2x}}{2}\right)$$

$$\frac{3e^{2x}+3e^{-2x}}{2}=3+\frac{e^{2x}-e^{-2x}}{2}$$

$$3e^{2x}+3e^{-2x}=6+e^{2x}-e^{-2x}$$

$$\cancel{3e^{2x}-e^{2x}+3e^{-2x}+e^{-2x}=6}$$

$$\cancel{3e^{2x}+3e^{-2x}=6+e^{2x}-e^{2x}e^{-2x}}$$

$$3e^{2x}+\frac{3}{e^{2x}}=6+e^{2x}-\frac{1}{e^{2x}}$$

let $e^{2x}=K$

$$\therefore\ 3K+\frac{3}{K}=6+K-\frac{1}{K}$$

$$3K^2+3=6K+K^2-1$$

$$3K^2-6K+4=0$$

$$K^2-3K+2=0$$

$$(K-1)(K-2)=0$$

$$K=1 \quad \# \quad K=2$$

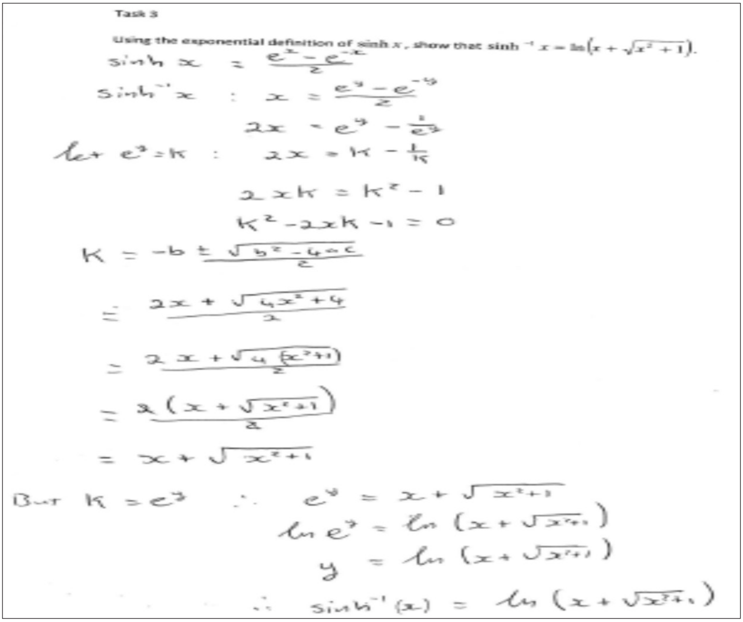
$$e^{2x}=1 \qquad e^{2x}=2$$

$$2x=\ln 1 \qquad 2x=\ln 2$$

$$x=\frac{\ln 1}{2} \qquad x=0{,}346$$

$$\therefore x=0$$

Figure 3: Written response for task 2


Task 3

Using the exponential definition of $\sinh x$, show that $\sinh^{-1} x = \ln\left(x + \sqrt{x^2+1}\right)$.

$\sinh x = \frac{e^x - e^{-x}}{2}$

$\sinh^{-1} x \; : \; x = \frac{e^y - e^{-y}}{2}$

$2x = e^y - \frac{1}{e^y}$

let $e^y = k$: $2x = k - \frac{1}{k}$

$2xk = k^2 - 1$

$k^2 - 2xk - 1 = 0$

$k = \frac{-b \pm \sqrt{b^2 - 4ac}}{2}$

$= \frac{2x + \sqrt{4x^2+4}}{2}$

$= \frac{2x + \sqrt{4(x^2+1)}}{2}$

$= \frac{2\left(x + \sqrt{x^2+1}\right)}{2}$

$= x + \sqrt{x^2+1}$

But $k = e^y$ $\therefore$ $e^y = x + \sqrt{x^2+1}$

$\ln e^y = \ln\left(x + \sqrt{x^2+1}\right)$

$y = \ln\left(x + \sqrt{x^2+1}\right)$

$\therefore \sinh^{-1}(x) = \ln\left(x + \sqrt{x^2+1}\right)$

Figure 4: Written response for task 3

displays a correct solution to the equation involving hyperbolic functions. This solution seems to have been aided by the use of substitution (see line 5 of Figure 3).

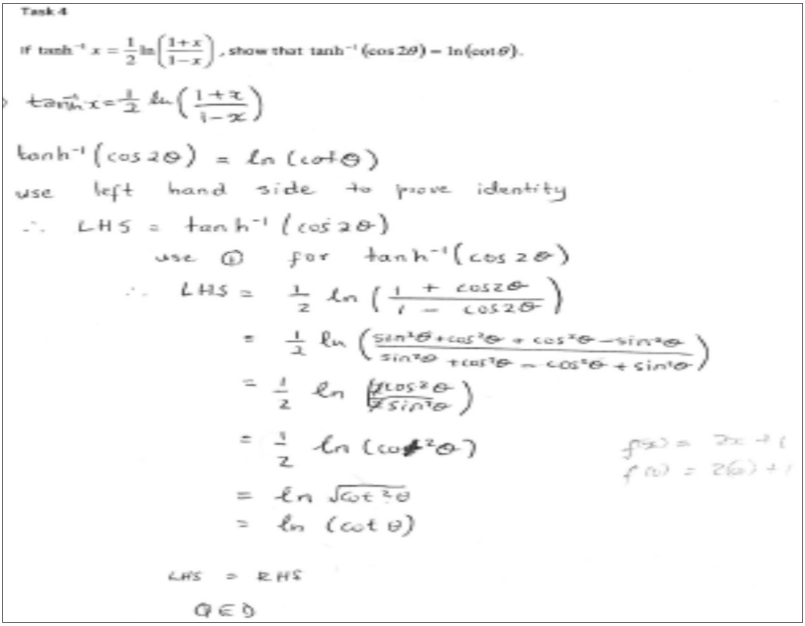
In solving this task the students showed that they could: 1) correctly define both the *sinh x* and *cosh x* functions, 2) operate on the problem to obtain unit denominators, 3) correctly apply the exponential law governing positive exponents, 3) solve trinomials successfully, and 4) apply the inverse of the exponential function when required. So it seems that the group discussions led to this perfect solution and demonstration of the relevant mathematical knowledge and skills. In Figure 4 we note the correct transformation of the inverse *sinh x* function to the natural logarithmic function.

In task 3 we observed that the students could:

1. use the correct definition of the hyperbolic function,
2. correctly apply the inverse function,
3. make a relevant substitution,

4. solve the given trinomial using the quadratic formula, and
5. appropriately introduce the natural logarithmic function as an inverse.

In assessment we generally find that this type of task provides a great deal of challenge to the first-year Engineering students doing this Mathematics course. They generally perform poorly in assessment tasks involving inverse functions. It seemed that in this case the group discussions promoted a perfect solution to task 3.



Task 4

If $\tanh^{-1} x = \frac{1}{2}\ln\left(\frac{1+x}{1-x}\right)$, show that $\tanh^{-1}(\cos 2\theta) = \ln(\cot\theta)$.

$\tanh^{-1} x = \frac{1}{2} \ln\left(\frac{1+x}{1-x}\right)$

$\tanh^{-1}(\cos 2\theta) = \ln(\cot\theta)$

use left hand side to prove identity

$\therefore$ LHS $= \tanh^{-1}(\cos 2\theta)$

use ① for $\tanh^{-1}(\cos 2\theta)$

$\therefore$ LHS $= \frac{1}{2} \ln\left(\frac{1 + \cos 2\theta}{1 - \cos 2\theta}\right)$

$= \frac{1}{2} \ln\left(\frac{\sin^2\theta + \cos^2\theta + \cos^2\theta - \sin^2\theta}{\sin^2\theta + \cos^2\theta - \cos^2\theta + \sin^2\theta}\right)$

$= \frac{1}{2} \ln\left(\frac{\cancel{2}\cos^2\theta}{\cancel{2}\sin^2\theta}\right)$

$= \frac{1}{2} \ln(\cot^2\theta)$

$= \ln\sqrt{\cot^2\theta}$

$= \ln(\cot\theta)$

LHS = RHS

QED

$f(x) = 2x + 1$

$f(0) = 2(0) + 1$

Figure 5: Written response for task 4

Task 4 also gave the first-year Engineering students a great deal of difficulty (see Figure 5), with a further daunting introduction of trigonometric functions. Despite the increased cognitive level of the task, the written response showed that the students could:

1. adopt the correct way of proceeding to prove an identity – as they started with the expression from the left-hand side and reduced it to an expression on the right-hand side,

2. manipulate the given information to allow them to introduce the natural logarithm,
3. appropriately introduce the Pythagorean trigonometric identity in line 7 of their solution, and
4. convert the sine and cosine functions into the cotangent function.

Task 5

The value of x given that sinh 2x = 1,343 is?

$$\sinh 2x = 1,343.$$
$$\frac{e^{2x}-e^{-2x}}{2} = 1,343$$
$$e^{2x}-e^{-2x} = 2,686$$
$$e^{2x} - \frac{1}{e^{2x}} = 2,686$$
Let $e^{2x} = K$
$$\therefore \quad K - \frac{1}{K} = 2,686$$
multiply by K : $K^2 - 1 = \frac{1343}{500}K$
$$K^2 - \frac{1343}{500}K - 1 = 0$$
$$(K - 3,0174)(K + 0,3314) = 0$$
$K = 3,0174$ or $K = -0,3314$

$e^{2x} = 3,0174$ or $e^{2x} = -0,3314$

$2x = \ln(3,0174)$ or $2x = \ln(-0,3314)$

$x = \frac{\ln(3,0174)}{2}$ or $x = \frac{\ln(-0,3314)}{2}$

$x = 0,552$ or x is undefined.

Figure 6: Written response for task 5

Task 5 (see Figure 6) was based on calculator usage. Again students demonstrated that they could use the required hyperbolic function definition appropriately. With a convenient substitution and correct calculator usage they were able to provide the expected correct solution to Task 5.

We observed via the five written responses that the students could solve all of these tasks successfully. We may hypothesise that such perfect solutions to the tasks arose from the classroom group dynamics which prevailed during this exploratory session. In order to gain more feedback in this regard we present the questionnaire responses. The questionnaire helped triangulate the data from the activity sheets and provided a means to evaluating the learning which took place during the collaborations.

In the questionnaire the first item asked whether the students enjoyed the learning activity based on the Gurteen Knowledge Café. All of the students indicated that they did. When asked to explain why they enjoyed this approach to learning, a variety of reasons were given. Some of these were:

1. it is easier understood when explained by another peer,
2. the students could ask questions to obtain clarity,
3. working with fellow students was better than sitting and listening to the lecturer,
4. you get more ways of solving mathematics problems,
5. working with peers avoids the fear generated when working with a lecturer,
6. the same tasks are seen from different perspectives,
7. the approach provides an open and comfortable atmosphere,
8. the approach was like playing a game and the students enjoyed playing along, and
9. the approach allowed building of relationships between the students.

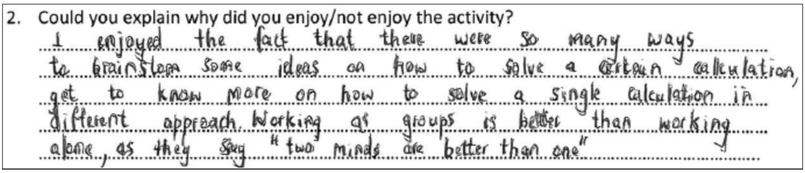

2. Could you explain why did you enjoy/not enjoy the activity?
I enjoyed the fact that there were so many ways to brainstorm some ideas on how to solve a certain calculation, get to know more on how to solve a single calculation in different approach. Working as groups is better than working alone, as they say "two minds are better than one"

Figure 7: Response of Student NLL to item 2 of questionnaire

Many of the reasons extracted from data from the questionnaire coincide with reasons provided in studies (Brijlall et al, 2006; Brijlall & Maharaj, 2009a, 2009b, 2011; Brijlall & Isaacs, 2011; Maharajh, Brijlall & Govender, 2008). Those studies did not employ the Gurteen Knowledge Café approach to foster collaborative learning. Hence, some views that were expressed would only be applicable to this study in which the Gurteen Knowledge Café approach was adopted. For instance, in the Gurteen Knowledge Café approach students rotate and migrate from group to group. In this way, as Student NLL (see Figure 7) points out, many ways of solving the same task arise.

2. Could you explain why did you enjoy/not enjoy the activity?

It make studying maths be almost like an enjoyable game which everyone can play it. Maths became simpler as we were like playing with it.

Figure 8: Questionnaire response of Student MM to item 2

Also, Student MM stated that he enjoyed this method of groupwork as he liked the way they moved around, as it was like playing a game (see Figure 8). Student NZ indicated that this approach helped him to meet and talk to other students in class that he would have not spoken to if not provided with this opportunity.

2. Could you explain why did you enjoy/not enjoy the activity?

ONE OF THE THINGS THAT I LOVED WAS BEING AN ANCHOR. BEING AN ANCHOR PUT ME IN A POSITION WHERE I HAD TO EXPLAIN THE CONCEPTS TO EVERYONE. EVEN THOUGH I'M NOT GOOD WITH EXPLAINING I HAD TO FIND WAYS TO CLEARIFY STEPS AND SOMETIMES USE OTHER EXAMPLES FOR EVERYONE TO BE KEPT IN THE LOO.

Figure 9: Questionnaire response of Student JG to item 2

2. Could you explain why did you enjoy/not enjoy the activity?

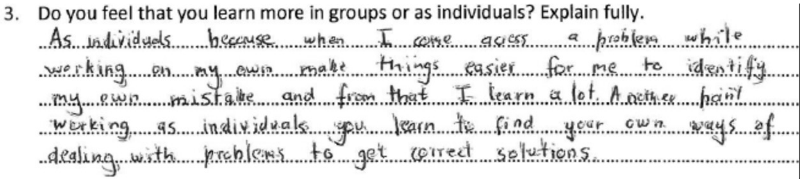
We were exposed to different questions that students had to complete and their explaination were getting better and better as everyone can ask the the anchor questions and a better understanding were made when the groups were swopped.

Figure 10: Questionnaire response of Student KSN to item 2

Another encouraging feature of the Gurteen Knowledge Café approach is that the anchor gets to explain the solution of a task to other students. In this way, as Student JG indicates in Figure 9, she had to explain the solution to other students entering her group at various stages. She says that in this way she could improve her communication skills. She also had to think of more examples to clarify queries raised by other students.

Student KSN also makes a valid point when he states that the Gurteen Knowledge Café approach allows students to be exposed to more than one task (which he calls questions). He also found that the explanations became more refined as more groups interrogated the task.

Item 3 of the questionnaire asked whether the students preferred groupwork or working individually. All except three students preferred working in groups. Reasons provided for group preference overlapped with the points which most students provided for item 2 of the questionnaire.


3. Do you feel that you learn more in groups or as individuals? Explain fully.

As individuals because when I come acess a problem while working on my own make things easier for me to identify my own mistake and from that I learn a lot. Another point working as individuals you learn to find your own ways of dealing with problems to get correct solutions

Figure 11: Questionnaire response of Student CPM to item 3

As far as the three students who preferred to work individually are concerned: Student MWQ preferred to work individually as he felt that group discussions were too noisy. Student MMS felt that she would prefer the lecturer explaining concepts to her, as the students might not know their mathematics. In Figure 11 we note the reason Student CPM provides for his preference for individual work: he feels that he would be able to identify his mistakes if he is working on his own. It should be noted that the results of this study cannot be generalised, as it is a small case study and only dealt with one aspect of Mathematics.

Conclusion

Data analysis in this study showed that the Gurteen Knowledge Café approach for collaborative learning benefitted the first-year Engineering students' learning of hyperbolic functions. These benefits were noted in both general learning dynamics and the appropriate use of mathematical knowledge and skills. In terms of the former, this study found that the Gurteen Knowledge Café approach: 1) offered many ways of solving a given task, 2) allowed for learning in a playful manner, 3) encouraged the anchors to meet all students (except the other anchors), 4) provided an opportunity for the anchor to become a specialist in the task s/he is assigned to, and 5) allows students to be exposed to all of the tasks.

In terms of the mathematical skills and knowledge, the Gurteen Knowledge Café approach encouraged:

1. correct definitions of hyperbolic functions,
2. effective application of exponential laws,
3. correct operations with algebraic fractions,
4. conversion of surds to exponential forms,
5. transformation of hyperbolic functions to natural logarithmic forms,
6. solving of trinomials, and
7. recall and application of trigonometric identities.

There was a minority of students (three out of 32) who preferred to work on an individual basis. The majority preferred the Gurteen Knowledge Café approach to learning.

References

Barkley, E.F., Cross, K.P. & Major, C.H. (2005) *Collaborative learning techniques: A handbook for college faculty* 1st edn. San Francisco: Jossey-Bass

Brijlall D., Maharaj, A. & Jojo, Z.M.M. (2006) The development of geometrical concepts through design activities during a Technology education class. *African Journal of Research in SMT Education,* 10, 1, 37-45

Brijlall, D. & Maharaj, A. (2009a) An APOS analysis of students' constructions of the concept of continuity of a single-valued function. in *Proceedings of the Seventh Southern Right Delta Conference on the Teaching and Learning of Undergraduate Mathematics and Statistics.* Stellenbosch, South Africa, 30 November 2009 – 4 December 2009, 36-49

Brijlall, D. & Maharaj, A. (2009b) Using an inductive approach for definition making: Monotonicity and boundedness of sequences. *Pythagoras,* 70, 68-79

Brijlall, D. & Maharaj, A. (2011) A framework for the development of mathematical thinking with pre-service teachers: The case of continuity of functions. *US-China Education Review B,* 1, 5, 654-668

Brijlall, D. & Isaacs, V. (2011) Links between content knowledge and practice in a mathematics teacher education course: A case study. *South African Journal of Higher Education,* 25, 4, 660-679

Center for Educational Leadership and Technology (2013) *Academic Induction Programme,* Durban, South Africa: Durban University of Technology

Cobb, P. (1994) Where is the mind? Constructivist and socio-cultural perspective in mathematical development. *Educational Researcher,* 23, 7, 13-20

Cohen, L., Manion, L. & Morrison, K. (2007) *Research methods in education,* 6th ed. London: Routledge

Confrey, J. (1990) A review of research on student conceptions in mathematics, science and programming. *Review of Research in Education,* 16, 3-55

Douglas, T. (2000) *Basic Groupwork,* 2nd ed. New York City, New York: Routledge

Eggen, P. & Kauchak, D. (2007) *Educational Psychology: Windows on classrooms,* 7th edn.

Upper Saddle River, NJ.: Merrill Prentice Hall

Gurteen, D. (2012) *Leading Issues in Social Knowledge Management*. Reading: Academic Publishing International

Henning, E. (2004) *Finding your way in qualitative research*. Pretoria: Van Schaik

Maharajh, N., Brijlall, D. & Govender, N. (2008) Preservice mathematics students' notions of the concept definition of continuity in calculus through collaborative instructional design worksheets. *African Journal of Research in SMT Education*, 12, 93-108

Noddings, N. (1990) Constructivism in mathematics education. Constructivist's' views on the teaching and learning mathematics. *Journal for Research in Mathematics Education*, Monograph 4, 7-18

Ornstein, A.C. & Hunkins, F.P. (2004) *Curriculum - Foundations, Principles, and Issues*. New York City, New York : Pearson Education

Piaget, J. (1970) *Genetic Epistemology*. New York: Columbia University Press

Piaget, J. (1972) *The Principles of Genetic Epistemology*. London: Routledge & Keegan Paul

Steffe, L.P. (1992) Prospects for alternate epistemologies in education. in L.P. Steffe (Ed.) *Constructivism in Education*. Hillside, NJ: Lawrence Erlbaum Associates (pp. 86-102)

Stroud, K.A. (2007) *Engineering mathematics*. Basingstoke, Hampshire: Palgrave Macmillan

Vithal, R., Adler, J. & Keitel, C. (2005) *Researching Mathematics Education in South Africa: Perspectives, practice and possibilities*. Pretoria: Human Sciences Research Council

.Vygotsky, L. (1978) *Mind in Society*. Cambridge, MA: Harvard University Press

Young, R.A. & Collin, A. (2004) Introduction: Constructivism and social constructionism in the career field. *Journal of Vocational Behavior,* 64, 373-388